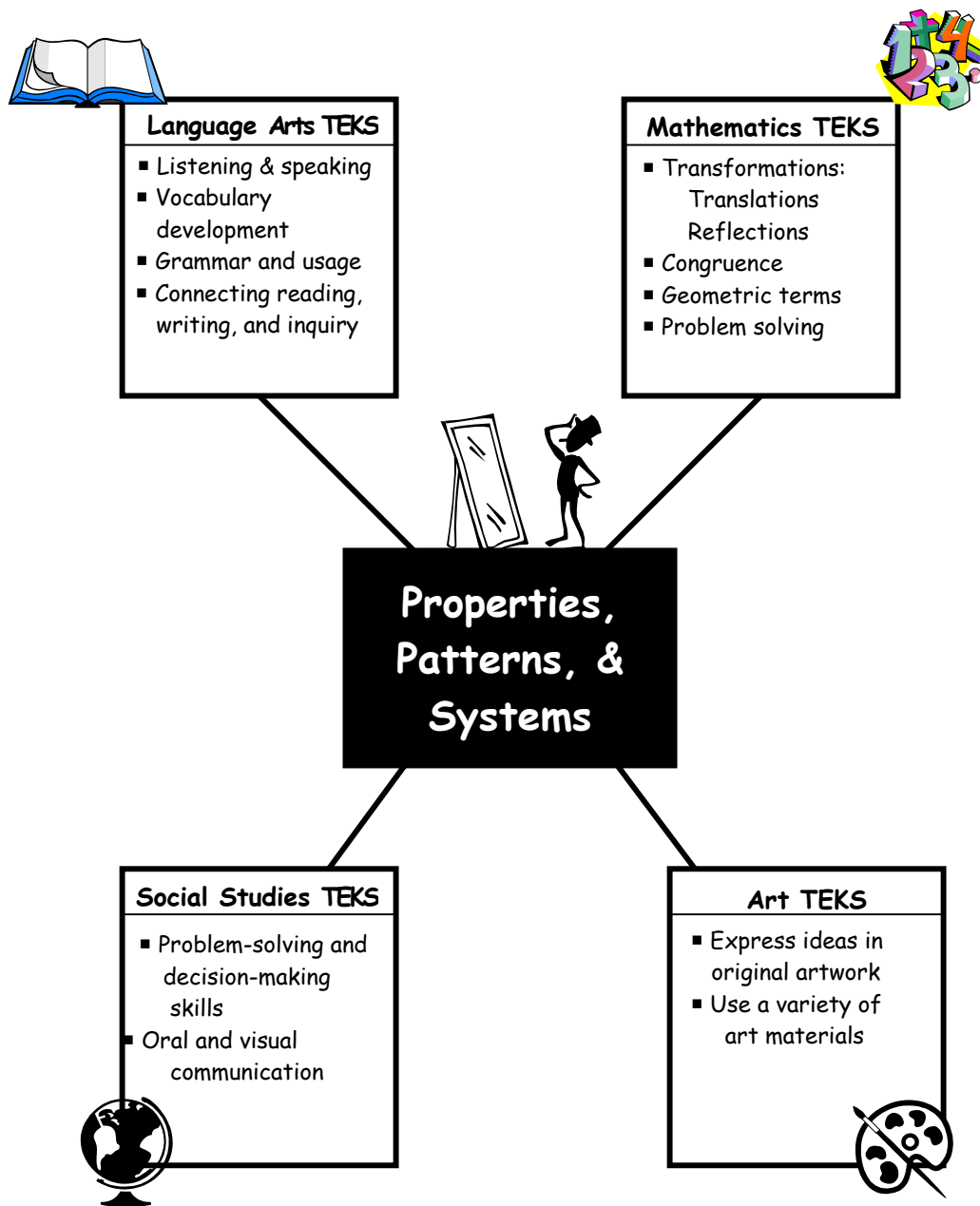


Interdisciplinary Connections

See page 22-25 for complete wording of the Texas Essential Knowledge & Skills for each content area addressed in this learning experience.



Overview of Learning Experiences

TEKS	<p>5.8 The student knows that energy occurs in many forms. The student is expected to: (B) identify and demonstrate everyday examples of how light is reflected, such as from tinted windows, and refracted, such as in cameras, telescopes, and eyeglasses</p> <p><i>To read complete TEKS student expectations for 5.8, see page 23.</i></p>
Engage	<ul style="list-style-type: none"> ◆ Students observe discrepant events involving reflection and refraction to establish a curiosity about light. ◆ Students record questions they have about the Bendable Mirror, Bent Barbie, and Copy Cat CD stations in their journals and on chart paper.
Explore	<ul style="list-style-type: none"> ◆ Students observe the behavior of light when it comes in contact with reflective and refractive surfaces such as mirrors, spoons, jars of water, convex lenses, and concave lenses.
Explain	<ul style="list-style-type: none"> ◆ Students discuss their observations of reflection and refraction, beginning with their own questions from the engage activity.
Elaborat	<ul style="list-style-type: none"> ◆ Students research reflecting and refracting telescopes as optical systems, and summarize their findings in a report that includes the parts of the telescope system and how they work.
Evaluate	<p style="text-align: center;">SUMMATIVE ASSESSMENT</p> <ul style="list-style-type: none"> ◆ Students demonstrate their understanding of reflection and refraction by completing a performance task, which includes classifying everyday examples of reflective and refractive materials into appropriate categories, and constructing a small telescope.

Reflecting on Refraction

Teaching Guide

Grade 5

ENGAGE

ENGAGE

1. Set up reflection and refraction stations for students to observe discrepant events that occur when light comes in contact with different materials.
2. Help students set up a section of their journal to use for recording observations. Revisit the importance of recording detailed information, including labeled drawings, in journal entries.
3. After observing the stations, students discuss questions they have about the events they observed, and list them on chart paper. Save these until the Explain section.

Lab Station One

1. Students observe the reflection of light rays from flat and curved mirrored surfaces.

Ask students to look at themselves first with the Mylar mirror flat, and then gently bend the sides of card outward so the center of the card curves out toward them to make a convex mirror. Then ask them to bend the sides of the card inward to make the middle of the card curve inward, or "cave in." (Most students will be surprised to see their image upside down!)

Station Two - The Bent Ruler

1. Have students make careful observations about the appearance of the ruler before and after placing it in the glass of water.
2. Have students record the observation and a labeled diagram in their journals. The laminated instruction card asks them to make an inference or and explanation about the behavior of light that could be causing the appearance of the ruler to change.

Materials (details p. 17)

For each group:

Station One

- ☐ large index card
- ☐ Mylar wrapping material
- ☐ glue stick
- ☐ scissors
- ☐ instruction card Master A
- ☐ Station Two
- ☐ Ruler
- ☐ Glass of water
- ☐ Instruction card Master B
- ☐ Station Three
- ☐ CD case
- ☐ Paper with color picture
- ☐ Blank white paper
- ☐ Instruction card Master C

- ☐ Chart paper
- ☐ markers

* Prior to the Engage activity, make or have students make flexible mirrors out of large index cards covered with aluminum foil or Mylar wrapping paper. The silvery-coated material makes a fairly good mirror if it is glued smoothly on the card with few bumps or folds.

Reflecting on Refraction

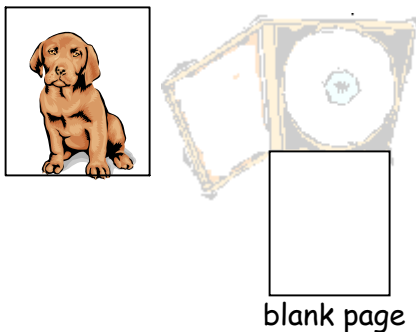
Teaching Guide

Grade 5

ENGAGE

Station Three - Copy Cat CD

1. Demonstrate how to open a clear plastic CD case, and position it so the clear section can be placed between two papers.
2. Place a paper with the decorative design on the left of the CD case, and the blank paper on the right.
3. Look into the plastic from the left side. Look through the clear plastic to the blank paper on the other side. Draw what you see on the blank paper.



Station One

- Did the Mylar make a good mirror? (*If it had any bumps or wrinkles, it didn't give a smooth reflection.*)
- How did your reflection appear when you made the center bend toward you? (*My face looked right side up, but it looked stretched out and distorted.*)
- How did your reflection appear when you made the center bend away from you? (*I looked smaller and upside down!*)

Reflecting on Refraction

Teaching Guide

Grade 5

ENGAGE

Questioning Strategies

Station Two

- How did the ruler appear out of the water? (*looked normal and in good condition.*)
- What did ruler look like in the water? (*appeared bent out of shape when submerged in water, but when I pulled it out of the water ruler looked normal again.*)
- How did the ruler appear out of the water? (*Straight*)
- What did it look like in the water? (*Crooked and bent*)
- What are the properties or characteristics of the glass of water? (*The glass of water has curved sides, and is half-filled filled with water. It is transparent, so light can pass through it.*)
- We know that we see an image of an object when light bounces off it, and enters our eyes. Why does a ruler appear to be bent when we see it in a clear, curved, water-filled container? (*As light passes through the water-filled glass, it is somehow bent before the light reflected by the ruler gets to our eyes.*)

Station Three

- Could you see a reflection of the picture on the blank page through the CD case? (*Yes, it was a faint reflection*)
- **How was the reflection different from the picture?** (*It was reversed*)
- Can you explain why you could see the reflection of the picture at the same time you could see the actual picture? (*Some of the light from the picture was reflected back to your eyes, while some of the light passed through or was transmitted through the CD case.*)

Questioning Strategies

Reflecting on Refraction**Teaching Guide****Grade 5****EXPLORE****EXPLORE**

1. Set up reflection and refraction stations for small group of students so they can make careful observations about the behavior of light when it comes in contact with reflective and refractive materials of different shapes.
2. Help students set up a section of their journal to use for recording observations. Revisit the importance of recording detailed information, including labeled drawings, in journal entries.

Station One - Flat Reflections

1. Students investigate how light rays reflect from mirrored surfaces.
2. Demonstrate how to fold the chart paper hamburger style, and draw a red line down the fold line.
3. Ask students to place the mirror in the binder clips or mirror holder, place the center of the mirror at one end of chart paper on the red centerline.
4. Demonstrate how to place one tube on one side of the red line, and shine the flashlight into the end.
5. Students need to determine where to place the second tube on the other side of the red line so light will shine up the first tube, bounce off the mirror, and shine down the second tube. Demonstrate how to tape down the tubes in the position that allows light to travel down one tube, bounce off the mirror, and hit the other tube.
6. Trace the lines formed by the insides of both tubes with a pencil. Remove the taped tubes. Using a ruler as a straight edge, draw a neat line of color over the pencil lines with a blue marker.

Materials (details p. 17-18)**For each group of students:****Station One**

- ☐ chart paper
- ☐ binder clips
- ☐ 2 cardboard tubes
- ☐ One mirror
- ☐ Flashlight
- ☐ Red and blue markers
- ☐ Master D

Station Two

- ☐ Ray protractor
- ☐ mirror
- ☐ flashlight or penlight
- ☐ binder clips or mirror clip
- ☐ Master E

Station Three

- ☐ shiny tablespoons
- ☐ slit cards
- ☐ flashlight
- ☐ Master F

Station Four

- ☐ black construction paper
- ☐ jar of water
- ☐ slit card
- ☐ binder clips or mirror clip
- ☐ Concave lens
- ☐ Convex lens
- ☐ Masters G

Station Five: OPTIONAL

- ☐ Ray box
- ☐ Black construction paper
- ☐ Demo convex lens
- ☐ Demo concave lens
- ☐ Demo convex mirror
- ☐ Demo concave mirror

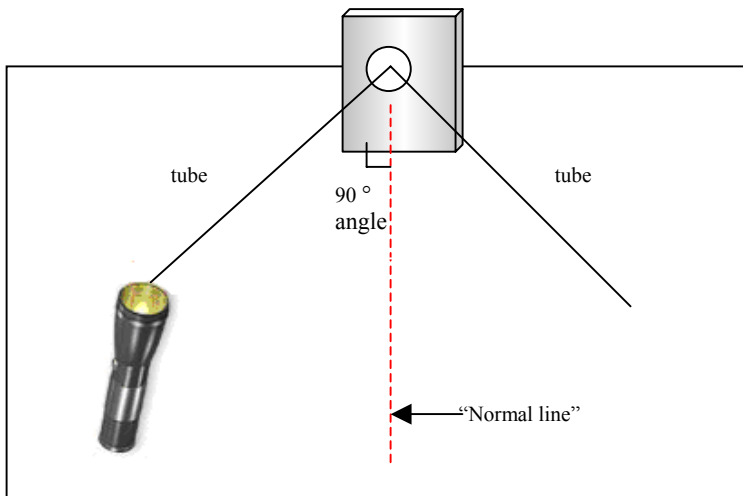
Reflecting on Refraction

Teaching Guide

Grade 5

EXPLORE

7. Remove the mirror from the chart paper. Refold the chart paper down the red line.



Questioning Strategies

- What happened to the light beam when it traveled up the first tube? *(It hit the mirror, bounced off, and traveled back down the second tube when it was positioned correctly)*
- Did the beam of light change direction? *(Yes, it bounced to the other side of the red line at an angle)*
- What is it called when light bounces off an object? (Reflection)
- What do you notice about the location of the blue lines? *They match up, or are the same when the chart paper is folded.*
- Is the red line parallel or perpendicular to the mirror? (Perpendicular, because it forms a right or 90° angle where it touches the mirror. In science, a line that is perpendicular to a mirror is called the "normal line", as the red line is labeled.)
- What did you notice about the location of the blue lines when the paper is folded? (They match up, or are the same.)
- What is another word for matching? (Congruent)

Reflecting on Refraction**Teaching Guide****Grade 5****EXPLORE**

Are any other parts of the diagram congruent? (*The angles between the red line and the mirror are also matching or congruent.*)

Station Two - What's the Angle?

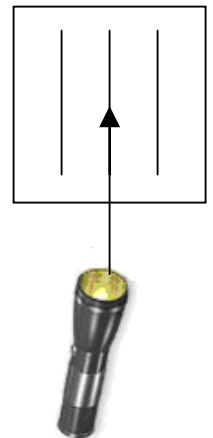
1. Demonstrate how to place a flat mirror on the back edge of the ray "protractor" designed to help them observe the angle of incidence and reflection without actually having to measure the angles. The center of the mirror should be placed at the center "normal" line marked zero.
2. After making predictions, they shine a beam at the lines marked 10, 20, 30, 40, 50, 60, 70 and 80 on the right side of the normal line, and record the number of the line on the left side of the reflection on the student data sheet.
3. Placing their finger near the predicted line of the reflected ray on the other side of the "protractor" helps students to see the exact direction of the light ray.)

Station Three - Spoon Images

Supply students with spoons and instructions to needed to complete the activity. Each student should record observations in their journal.

Station 4- Refraction

1. Students test clear, curved water-filled jars and lenses with light rays to discover if they bend light rays, using a slit card to make beams of light.
2. Ask students to place the water-filled baby food jars in the middle of the black construction paper, in front of the narrow slits on the card. Darken the room, and shine a flashlight through the slits in the card.
3. Ask students to draw the refraction system in their journals, with labels for the jar, the rays before entering the jar, and after entering the jar.



Reflecting on Refraction**Teaching Guide****Grade 5****EXPLORE****Station 4**

1. Hand out a convex lens for each table, and ask students to feel the shape of the lens on their table, and ask them to describe how it feels. (*It bulges in the center.*) *Have them draw and label a convex lens in their journal.*
2. Repeat the same thing with the concave lens, and ask them to describe how it feels. (*It caves in toward the middle.*) *Have them draw and label a convex lens in their journal.*
3. Ask students to test the lenses in the same manner as they did the water-filled jar.
4. Students should draw a picture for each lens system, showing the shape of the lens and where it was sitting on the paper. Each drawing should have labels for the type of lens, the rays before entering the lens, and after entering the lens. Each student also should record results shown in the instruction page on the data sheet by drawing how each lens changed the direction of the light rays.

OPTIONAL Station 5

1. Students compare how light reflects off concave and convex mirrors using a electrical ray box.
2. Students compare how light refracts when it goes through concave and convex lenses, using a electrical ray box.

Reflecting on Refraction

Teaching Guide

Grade 5

EXPLAIN

EXPLAIN

Discuss student observations at the reflection and refraction station.

1. Begin discussion with the questions they wrote on their charts after the engage activity.
2. Ask students to keep questions in mind during discussion. As questions are answered by observations or inferences from other students, write a brief answer on the chart paper.

Station One- Flat Reflections

- What happened to the light beam when it traveled up the first tube? *(It hit the mirror, bounced off, and traveled back down the second tube when it was positioned correctly)*
- Did the beam of light change direction? *(Yes, it bounced to the other side of the red line at an angle)*
- What is it called when light bounces off an object? *(Reflection)*
- What do you notice about the location of the blue lines? *(They match up, or are the same when the chart paper is folded.)*
- Is the red line parallel or perpendicular to the mirror? *(Perpendicular, because it forms a right or 90° angle where it touches the mirror. In science, a line that is perpendicular to a mirror is called the "normal line", as the red line is labeled.)*
- What do you notice about the blue lines when the paper is folded? *(They match up, or are the same.)*
- What is another word for matching? *(Congruent)*
- Are any other parts of the diagram congruent? *(The angles between the red line and the mirror are also matching or congruent.)*

Reflecting on Refraction**Teaching Guide****Grade 5****EXPLAIN****Station Two - What's the Angle**

- If the light beam was aimed toward the 30-degree mark, where did it go after it hit the mirror? *(It went out at the 30 degree mark on the other side of the normal line.)*
- Did you notice a pattern about the reflection of rays? *(The place a light beam hits the mirror determines where it will bounce or reflect off. This is called the Law of Reflection.)*

Station Three - Spoon Images

- What happens when light from a flashlight or ray box strikes a convex mirror? *(As light rays hit the curves, they are spread out as they bounce back.)*
- What happens when light rays strike a concave mirror? *(The rays bend and meet at a focus in the middle.)*

Stations 4 and 5 - Refraction

- How do the rays of light look as they went towards the jar? *(They looked like straight, parallel rays with an even distance between them.)*
- How do the rays of light look after they leave the jar? *(The light rays bent as they left the jar, and were no longer parallel, because they crossed each other after passing through water. Light rays can travel in a straight line until they come into contact with an object that reflects or refracts them.)*
- What happened when the light rays crossed? *(It looked very bright where the light rays crossed each other.)*
- What does a clear, curved jar of water do to light rays? *(It bends them, and makes them change direction.)*
- Show students the convex lens, and ask them to discuss the properties of a convex lens. *(Clear or transparent, curved, thicker in the center than on the edges.)*

Reflecting on Refraction**Teaching Guide****Grade 5****EXPLAIN**

- Show students the concave lens, and ask them to discuss the properties of a concave lens (*Clear or transparent, curved, thicker on the edges than in the center.*)
- What happened to the light rays when they went through the convex lens? (*The light rays were parallel before they went through the lens, and then they bent in, came closer to each other and crossed after going through the convex lens.*)
- What happened to the light rays when they went through the concave lens? (*The light rays were parallel before they went through the lens, then they bent and spread outwards after going through the concave lens.*)

Reflecting on Refraction**Teaching Guide****Grade 5****ELABORATE****ELABORATE**

Using references and on-line resources, students research refracting and reflecting telescopes as optical systems.

A list of useful websites for telescopes may be book marked prior to class to streamline the research process. If there are not enough computers available for all students to research on line, have reference books available for part of the class to use while the others research on-line, then switch.

After research, students summarize their findings in a written report that compares reflecting and refracting telescope systems:

A. Reflecting Telescopes

1. The parts of a reflecting telescope system
2. How the parts of the reflecting telescope work together to look at far away objects
3. Advantages and disadvantages of reflecting telescopes

B. Refracting Telescopes

1. The parts of a refracting telescope system.
2. How the parts of the refracting telescope work together to look at far away objects.
3. Advantages and disadvantages of refracting telescopes

C. Students demonstrate understanding of reflection and refraction telescope systems by constructing a small telescope.

1. Hand out the telescope kits, and allow each group enough time to put the telescope together.
2. After everyone tests the telescope to be sure it is functional, each student should draw a labeled diagram of the telescope, and identify it as a reflecting or refracting telescope.

Materials (details p. 19)

- ☐ Computers w/ Internet access
- ☐ Astronomy reference books
- ☐ Student journals
- ☐ Telescope kits

EVALUATE

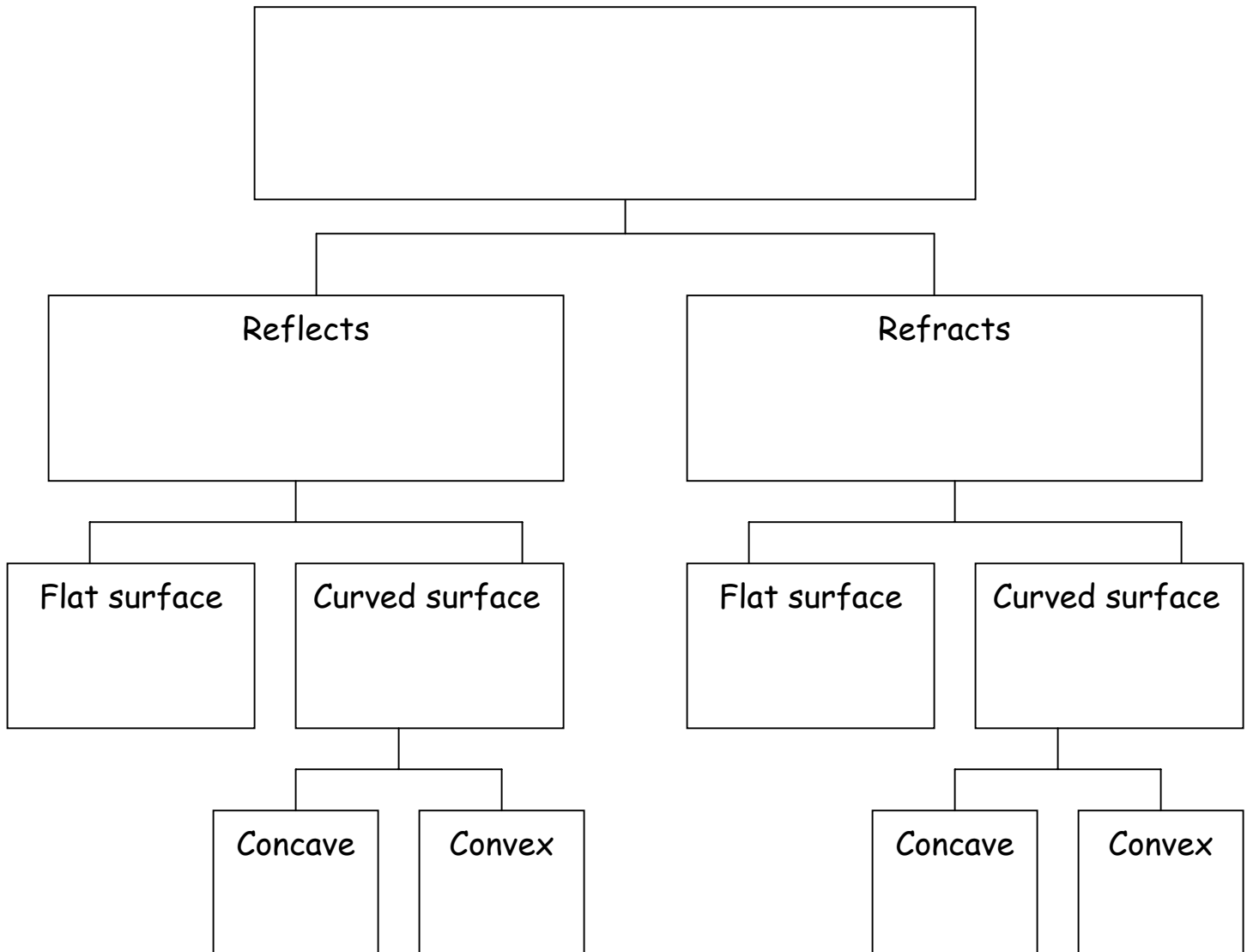
A. Students complete a graphic organizer and writing assignment that allows them to demonstrate their understanding of reflection and refraction by classifying everyday examples of objects used to reflect and refract light into appropriate categories.

Materials (details p. 19)

- ☐ 6 objects for classifying
- ☐ Graphic organizer, Master H
- ☐ rubric

Reflecting on Refraction**Assessment** See Master H

A. Observe the items in the container. Classify each item as an object that is used to reflect or refract light. Then, further classify each example as having a flat or curved surface. Divide the objects with curved surfaces into convex or concave surfaces. Write the name of the items in the appropriate box.



B. Select one object from the "reflects" branch and one item from the "refracts" branch to write about their uses and properties. Describe what the object can be used for and how the properties of each object make it useful for reflecting or refracting light.

Reflecting on Refraction Assessment Scoring Rubric

TASK	CRITERIA	1	2	3	4
Reflection and Refraction Performance Task	Classifies everyday items as reflective or refractive, and then further classifies them by surface shape	Classifies three items correctly	Classifies four items correctly	Classifies five items correctly	Classifies six items correctly
Communicates understanding through writing	Describes the use and properties of a reflective and a refractive object	Descriptions are limited and include major misconceptions	Descriptions are limited with few or no specifics; may include misconceptions	Descriptions are adequate and correct but few specifics and details are included	Descriptions are specific, detailed, and correct

Materials Detail Sheet

ENGAGE

For each group:

Station One

- ☐ large index card
- ☐ mylar wrapping material; available from craft and discount stores in wrapping department
- ☐ glue stick; available at craft stores(\$1.75 for 30)
- ☐ scissors
- ☐ Copy Master A (on blue card stock and laminated)

Station Two

- ☐ Barbie doll with bathing suit; available new at discount stores, but may be donated for the activity
- ☐ Glass of water
- ☐ Copy Master B (on blue card stock and laminated)

Station Three

- ☐ CD case: remove color labels from the inside so just the clear plastic remains
- ☐ Paper with color picture: use a brightly colored picture for best results
- ☐ Blank white paper
- ☐ Copy Master C (on blue card stock and laminated)
- ☐ Chart paper
- ☐ markers

EXPLORE

For each group of students:

Station One

- ☐ chart paper
- ☐ binder clips ; used to hold up mirror; find at office supply
- ☐ 2 cardboard tubes; paper towel rolls may be used
- ☐ One mirror
- ☐ Flashlight
- ☐ Red and blue markers
- ☐ Copy Masters D-E (on green card stock and laminated)

Materials Detail Sheet

Station Two

- ☐ Ray protractor
- ☐ mirror
- ☐ flashlight or penlight
- ☐ binder clips or mirror clip
- ☐ Copy Master F (on green card stock and laminated)

Station Three

- ☐ **shiny** spoons; available at discount stores in housewares
- ☐ slit cards; available from vendors of science teaching supplies by catalog order
- ☐ flashlight
- ☐ Copy Masters G-H (on green card stock and laminated)

Station Four

- ☐ black construction paper
- ☐ jar of water; baby food or curved jars without decoration or etching
- ☐ slit card; available from vendors of science teaching supplies by catalog order
- ☐ binder clips or mirror clip
- ☐ Concave lens; available from vendors of science teaching supplies by catalog order
- ☐ Convex lens; available from vendors of science teaching supplies by catalog order

Station Five

- ☐ Ray box; available from vendors of science teaching supplies by catalog order (\$110.00)
- ☐ Black construction paper
- ☐ Demo convex lens; available from vendors of science teaching supplies by catalog order (set for \$30.00)
- ☐ Demo concave lens; included in set price above
- ☐ Demo convex mirror; included in set price above
- ☐ Demo concave mirror; included in set price above

Materials Detail Sheet

EXPLAIN

For the class:

- ☐ Posted chart paper with questions

ELABORATE

For the class:

- ☐ List of internet resources
- ☐ Reference books on telescopes

For each group of students

- ☐ refracting telescopes kit; (\$8.00);available from Leaning Technologies, Inc. (1-800-537-8703)

For each student:

- ☐ journal for note taking

EVALUATE

For each student:

- ☐ container of 6 items: 3 reflective; 3 refractive
 - Reflector suggestions:
 - Flat: mirror, bicycle reflector
 - Convex: side view mirror insert
 - Concave: make-up mirror, flashlight head reflector
 - Refractor suggestions:
 - Flat: prism
 - Convex: hand lens
 - Concave: concave lens
- ☐ Reflecting on Refraction scoring Rubric

Background Information for Teachers

"The important but abstract ideas of science, such as atomic structure of matter and the conservation of energy, all begin with observing and keeping track of the way the world behaves. When carefully observed, described, and measured, the properties of object, changes in properties over time, and the changes that occur when materials interact provide the necessary precursors to the later introduction of more abstract ideas in the upper grade levels. By experimenting with **light**, heat, electricity, magnetism, and sound, students begin to understand that phenomena can be observed, measured, and controlled in various ways." (National Science Education Standards, p. 126)

There are many sources of light, (lamp, overhead, flashlight) but all of these sources ultimately get their energy from the sun. The sun gives off energy that travels in waves. Some of these waves are known as visible light, which we can see as beams or rays of light. Because light travels in waves, it has certain properties and follows certain patterns. One important property is that a light wave travels in a straight line, unless it comes into contact with an object that changes its direction.

Light rays travel in straight lines until they reflect or bounce off a surface or an object, in much the same way that a thrown rubber ball bounces off a wall. The texture of the surface determines how much light will be reflected or absorbed. Mirrors have smooth shiny surfaces that absorb very little light, so they reflect light in almost exactly the same pattern as it hits, which allows us to see a complete reflected image of objects. Mirrors can reflect images of objects because light rays bounce off an object, travel in a straight line to a mirror, bounce off the mirror, and then travel to the eye of an observer. The law of reflection states that if light hits a reflective surface at a certain angle, (angle of incidence), it will reflect or bounce off at the same angle, (angle of reflection.) To determine the angle of incidence and reflection we use the normal line as zero, which is a line that is perpendicular to the center of the mirror. If a light ray hits a mirror at 60 degrees from the normal, then it will reflect off the mirror at 60 degrees on the opposite side of the normal.

Refraction, or bending of light rays, occurs when light travels from one transparent substance to another. The amount of refraction depends on the angle at which light enters the new substance, and the difference in the densities of the two substances, such as air and glass. The angle that a light ray enters a substance is measured from the normal, which is an imaginary line that is perpendicular to the boundary between the two substances. The greater the angle, the more the

Reflecting on Refraction**Teaching Guide****Grade 5**

light ray will be bent. This is why lenses with a great amount of curvature provide more magnification than flatter lenses.

When light moves from air into water or a lens, it slows down and changes direction. A Barbie in a glass of water appears to be bent because light rays were bent and slowed down as they went from air to water. Placing a large bottle of water in front of newsprint makes the letters appear wider and larger, because it bends the light inward, making it appear to the eye that the light rays are coming from much wider print.

Lenses also bend light rays. A convex lens has a curved outside edge, so it is thicker in the middle of the lens. Light rays passing through a convex lens meet at one point and then cross, which magnifies objects and turns them upside down. Convex lenses are used in movie and slide projectors, and in eyeglasses for far-sighted people. A concave lens "caves in" in the middle, so it is thin in the middle and thick on the outer edges. Light rays passing through concave lenses spread out, so objects look smaller through concave lenses. Concave lenses are used in cameras and eyeglasses for near-sighted people. The magnifying power of a lens is related to its shape. There are many useful devices that form images by refraction, such as eyeglasses, cameras, binoculars, microscopes, and telescopes. All of these devices use curved glass or plastic lenses to slow and bend light rays.

All of these devices use curved glass or plastic lenses to slow and bend light rays. A telescope is a device that makes far away objects look closer by collecting and focusing the light reflected by an object, funneling the light into a bright image, and magnifying it on its way to the retina of the eye. A refracting telescope is made of two convex lenses and a tube that allows adjustment of the distance between the two lenses. At the end of the tube is closest to the object being viewed, a large, weak objective lens is used to collect and focus the light reflected from the distant object. At the end of the tube closest to the eye, a smaller, stronger eyepiece lens is used to magnify the focused image before the image is formed on the retina. A powerful telescope makes far away objects look bigger (called magnifying power) and brighter (called light gathering power). **Never** look at the sun using any telescope, because the light that is collected, focused, and magnified will burn the retina of the eye.

A homemade telescope can easily be made using two magnifying glasses (one larger in diameter than the other,) cardboard tubes, tape, and a piece of newspaper. Students can use these "moon tubes" to observe the moon's characteristics and phases.

Targeted



Texas Essential Knowledge & Skills



Science TEKS

- 5.1** The student conducts field and laboratory investigations following home and school safety procedures and environmentally appropriate and ethical practices. The student is expected to:
- (A) demonstrate safe practices during field and laboratory investigations
- 5.2** The student uses scientific methods during field and laboratory investigations. The student is expected to:
- (B) collect information by observing and measuring
 - (C) analyze and interpret information to construct reasonable explanations from direct and indirect evidence
 - (D) communicate valid conclusions
 - (E) construct simple graphs, tables, maps, and charts using tools including computers to organize, examine, and evaluate information
- 5.3** The student uses critical thinking and scientific problem solving to make informed decisions. The student is expected to:
- (A) analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information
 - (F) represent the natural world using models and identify their limitations
 - (E) connect Grade 5 science concepts with the history of science and contributions of scientists
- 5.4** The student knows how to use a variety of tools and methods to conduct science inquiry. The student is expected to:
- (A) collect and analyze information using tools including calculators, **microscopes**, **cameras**, sound recorders, computers, hand **lenses**, **rulers**, thermometers, compasses, balances, hot plates, **meter sticks**, timing devices, magnets, collecting nets, and safety goggles

Reflecting on Refraction**Teaching Guide****Grade 5**

- 5.8** The student knows that energy occurs in many forms. The student is expected to:
- (A) differentiate among forms of energy including light, heat, electrical, and solar energy
 - (B) identify and demonstrate everyday examples of how light is reflected, such as from tinted windows, and refracted, such as in cameras, telescopes, and eyeglasses

**Language Arts TEKS**

- 5.1** Listening/speaking/ purposes. The student listens actively and purposefully in a variety of settings. The student is expected to:
- (A) determine the purposes for listening such as to gain information, to solve problems, or to enjoy and appreciate
- 5.5** Listening/speaking/audiences. The student speaks clearly and appropriately to different audiences for different purposes and occasions. The student is expected to:
- (E) give precise directions and instructions such as in games and tasks
 - (F) clarify and support spoken ideas with evidence, elaborations, and examples
- 5.8** Reading/variety of texts. The student reads widely for different purposes in varied sources. The student is expected to:
- (B) select varied sources such as nonfiction, novels, textbooks, newspapers, and magazines when reading for information or pleasure
- 5.9** Reading/vocabulary development. The student acquires an extensive vocabulary through reading and systematic word study. The student is expected to:
- (E) study word meanings systematically such as across curricular content areas and through current events
- 5.13** Reading/inquiry/research. The student inquires and conducts research using a variety of sources. The student is expected to:
- (A) form and revise questions for investigations, including questions arising from interests and units of study

Reflecting on Refraction**Teaching Guide****Grade 5**

5.15 Writing/purposes. The student writes for a variety of audiences and purposes, and in a variety of forms. The student is expected to:

- (A) write to express, discover, record, develop, reflect on ideas, and to problem solve
- (C) write to inform such as to explain, describe, report, and narrate

5.21 Writing/inquiry/research. The student uses writing as a tool for learning and research. The student is expected to:

- (A) frame questions to direct research
- (B) take notes from relevant and authoritative sources such as guest speakers, periodicals, or on-line searches

**Mathematics TEKS**

5.7 Geometry and spatial reasoning. . The student generates geometric definitions using critical attributes. The student is expected to:

- (A) identify critical attributes including parallel, perpendicular and congruent parts of geometric shapes and solids
- (B) use critical attributes to define geometric shapes or solids.

Geometry and spatial reasoning. The student models transformations. The student is expected to:

- (A) sketch the results of translations, rotations, and reflections

5.11 Measurement. The student applies measurement concepts. The student is expected to:

- (A) measure to solve problems involving length (including perimeter), weight, capacity, time, temperature, and area

5.14 Underlying processes and mathematical tools. The student applies Grade 5 mathematics to solve problems connected to everyday experiences and activities in and outside of school. The student is expected to:

- (C) select or develop an appropriate problem-solving strategy, including drawing a picture, looking for a pattern, systematic guessing and checking, acting it out, making a table, working a simpler problem, or working backwards to solve a problem

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5.15 Underlying processes and mathematical tools. The student communicates about Grade 5 mathematics using informal language. The student is expected to:

- (A) explain and record observations using objects, words, pictures, numbers, and technology

5.16 Underlying processes and mathematical tools. The student uses logical reasoning to make sense of his or her world.

- (A) make generalizations from patterns or sets of examples and nonexamples

**Social Studies TEKS**

5.26 Social Studies skills. The student communicates in written, oral, and visual forms. The student is expected to:

- (C) express ideas orally based on research and experiences
- (D) create written and visual material such as journal entries, reports, graphic organizers, outlines, and bibliographies
- (C) use standard grammar, spelling, sentence structure, and punctuation.

5.27 Social studies skills. The student uses problem-solving and decision-making skills, working independently and with others, in a variety of settings. The student is expected to:

- (A) use a problem-solving process to identify a problem, gather information, list and consider options, consider advantages and disadvantages, choose and implement a solution, and evaluate the effectiveness of a solution

**Art TEKS**

4.2 Perception. The student develops and organizes ideas from the environment. The student is expected to:

- (A) communicate ideas about feelings, self, family, school, and community, using sensory knowledge and life experiences

Reading Connections

The following books are recommended as literary resources for teachers to share with grade 5 students. **Teachers are cautioned, however, to remember that “reading about science” is not “doing science.”** Books can enhance students' study of reflection and refraction but cannot replace the learning that occurs by active engagement in the learning experiences.

Explorabook: A Kid's Science Museum in a Book. John Cassidy. Klutz Press, 1991.

More Telescope Power: All New Activities and Projects for Young Astronomers. Matloff, Gregory. John Wiley & Sons, 2002.
ISBN 0471409855

Student Internet Links

Beakman and Jax Science Stuff
<http://www.beakman.com/>

Bill Nye the Science Guy
<http://nyelabs.kcts.org/>

Energy Quest
<http://www.energy.ea.gov/education/index.html>

Interactive Reflection Tutorial
<http://micro.magnet.fsu.edu/primer/lightandcolor/reflection.html>

Optics for Kids
<http://www.opticalres.com/kidoptx.htm>

Interactive Reflection Tutorial
<http://micro.magnet.fsu.edu/primer/java/scienceopticssu/reflection/index.html>

“Do-It-Yourself” instructions for making a model of the Hubble Space Telescope
<http://sol.stsci.edu/~mutchler/HSTmodel.html>

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How Stuff Works "How Telescopes Work"

<http://www.howstuffworks.com/telescope.htm>

NASA Homepage

<http://www.nasa.gov/>

Space Day Interactive Site

<http://www.spaceday.com/>

References

Ardley, Neil. *The Science Book of Light*. Gulliver Books, New York, 1991.

Benchmarks for Science Literacy. Oxford University Press, New York, 1993.

Bonnet, Robert L. *Space and Astronomy*. TAB Books, Blue Ridge Summit, PA, 1992.

Broekel, Ray. *Experiments with Light*. Children's Press, Chicago, 1986.

Burnie, David. *Light*. Dorling Kindersley, 1992.

Levine, Shar, and Johnstone, Leslie. *The Optics Book*. Sterling Publishing Co. Inc, 1998.

National Science Education Standards. National Academy Press, Washington, DC, 1996.

Wood, Robert W. *Physics for Kids: 49 Easy Experiments with Optics*. TAB Books, 1990.

Websites

Exploratorium

<http://www.exploratorium.edu/>

Explore Science

<http://www.explorescience.com/>

Marshall Brain's How Stuff Works: How Light Works

<http://www.howstuffworks.com/light5.htm>